NASA TECH BRIEF

Lewis Research Center

Computer Program for Quasi-Three-Dimensional Calculation of Surface Velocities and Choking Flow for Turbomachine Blade Rows

The aerodynamic design of turbomachinery blades requires the determination of the blade surface velocity distribution. Also, it is often necessary to know the choking mass flow. In many blade designs, there are significant velocity gradients both from blade to blade and from hub to tip; this condition necessitates consideration of three-dimensional effects.

One of the useful techniques for calculating surface velocities where three-dimensional effects are of importance is the velocity gradient (stream filament) method. The general velocity gradient equation determines the velocity variation in any direction. In particular, the velocity gradient equation can be reduced to special cases to determine both the blade-to-blade and hub-to-tip variation in velocity. A combination of the velocity variation in two directions with a specified mass flow will determine the velocities at a passage cross section. This method works well in a well-guided passage. Reference 1 applies this method to axial flow turbines. The computer program (CTTD) in reference 1 has been used in turbine design for many years by NASA and industry.

A new program, CHANEL, has been written. CHANEL is more general than CTTD and can obtain quasi-three-dimensional solutions in any well-guided channel. Some of the conditions that can be handled by the CHANEL program that could not be handled previously are non-uniform inlet temperature, pressure, and prewhirl, and nonaxial flow where meridional flow angle, meridional streamline curvature, and radius can vary as desired from the hub to tip. Also, output has been clarified, and additional output information is given.

Reference 2 gives a description of the analysis procedure and of the use of the CHANEL program.

Note:

1. This program is written in FORTRAN IV to be used on the IBM 7094 computer.

2. The following documentation may be obtained from:
   National Technical Information Service
   Springfield, Virginia 22151

   Reference 1: NASA TM-X-1394 (N67-27572), A Quasi-Three-Dimensional Method for Calculating Blade-Surface Velocities for an Axial Flow Turbine Blade
   Single document price $6.00
   (or microfiche $0.95)

   Reference 2: NASA TN-D-6177 (N71-23126), FORTRAN Program for Quasi-Three-Dimensional Calculation of Surface Velocities and Choking Flow for Turbomachine Blade Rows,
   Single document price $3.00
   (or microfiche $0.95)

3. Inquiries concerning this program should be directed to:

   COSMIC
   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: LEW-11635

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